LOUISIANA
DEPARTMENT OF HEALTH
AND HOSPITALS

Abstract

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Presentation Title: Hospital Access, a 2-Step Floating Catchment Area Application
Topic Category: Public Health, Hospitals and Health Systems
Company name: Louisiana Department of Health and Hospitals

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Tyler Carruth: MMIS Modernization Director, Louisiana Department of Health & Hospitals; Masters Health Informatics, UT School of Biomedical Informatics

Abstract
Louisiana Dept. of Health & Hospitals is spatially quantifying statewide inpatient, acute care hospital supply disparities by carefully specifying supply and demand. Network analysis is applied between those nodes and is critical in quantifying access. Stewards of centralized health information can fulfill their role as the source for global data and GIS application by publicly sharing such products to better inform all stakeholders.

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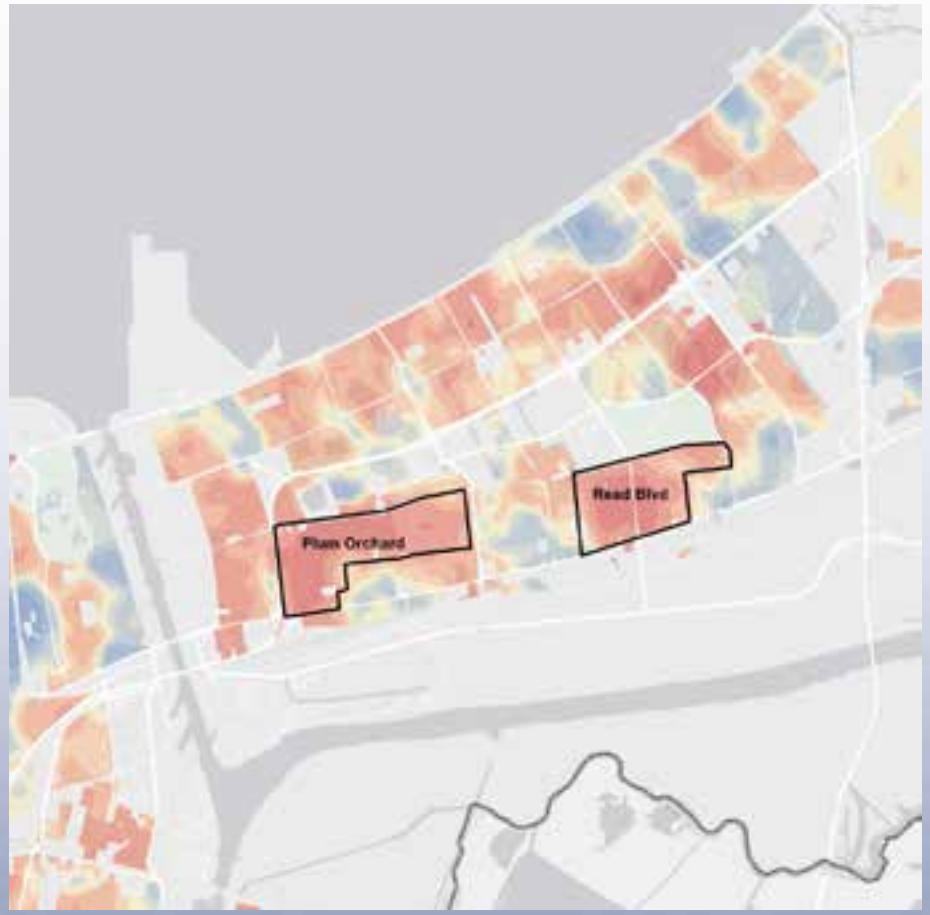
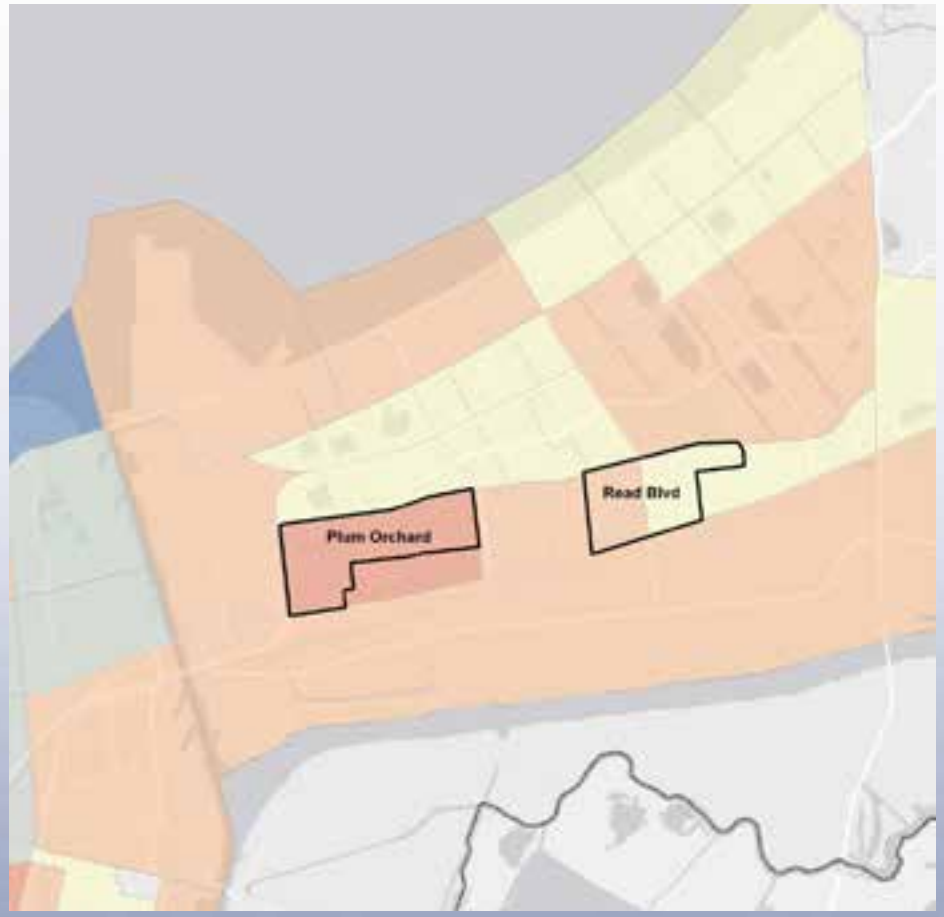
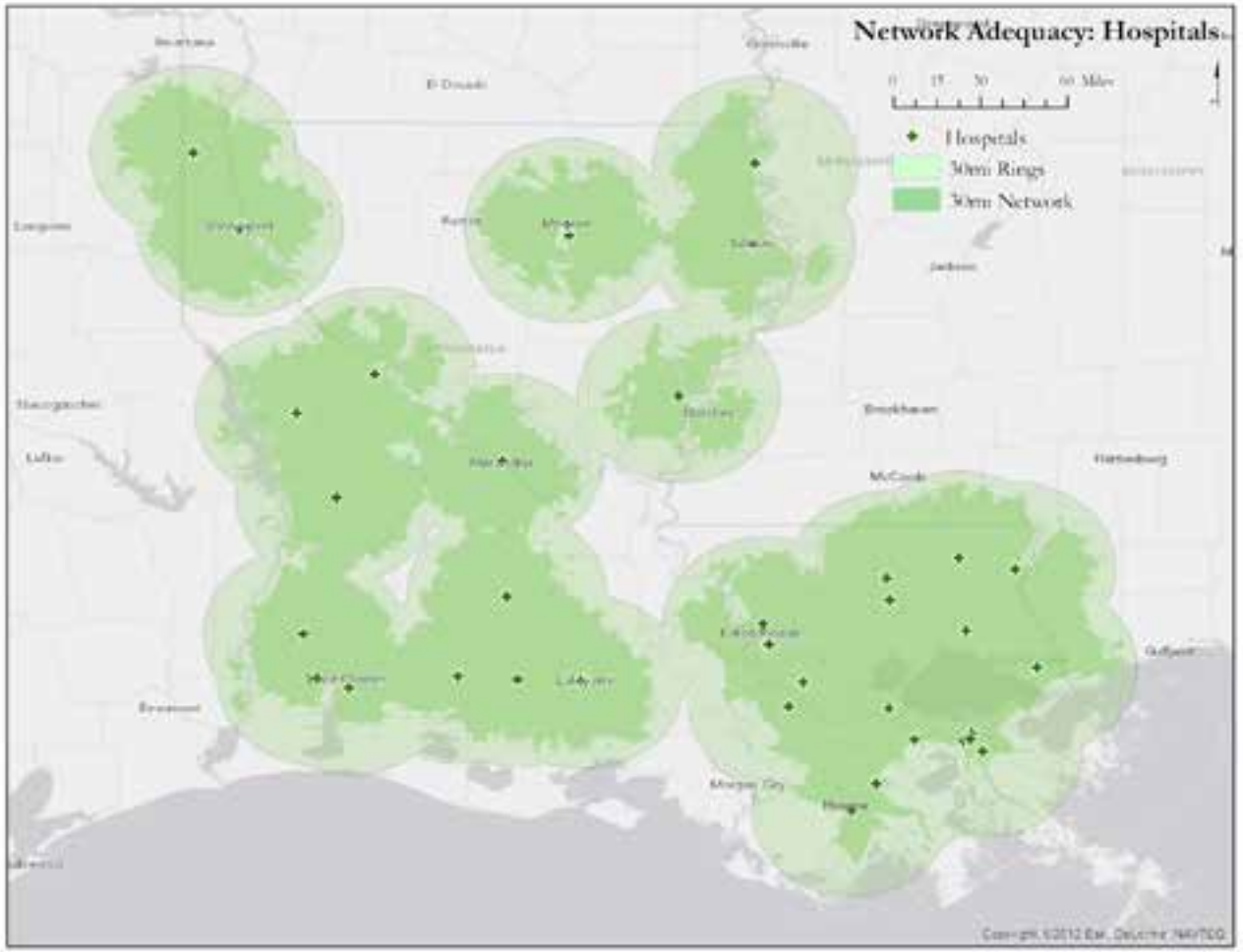
Hot Spotting Low Birth Weight (UC12')





Read Blvd. area is split by two tracts (right image) partially masking a LBW anomaly.

Hospital Network Adequacy (UC13')



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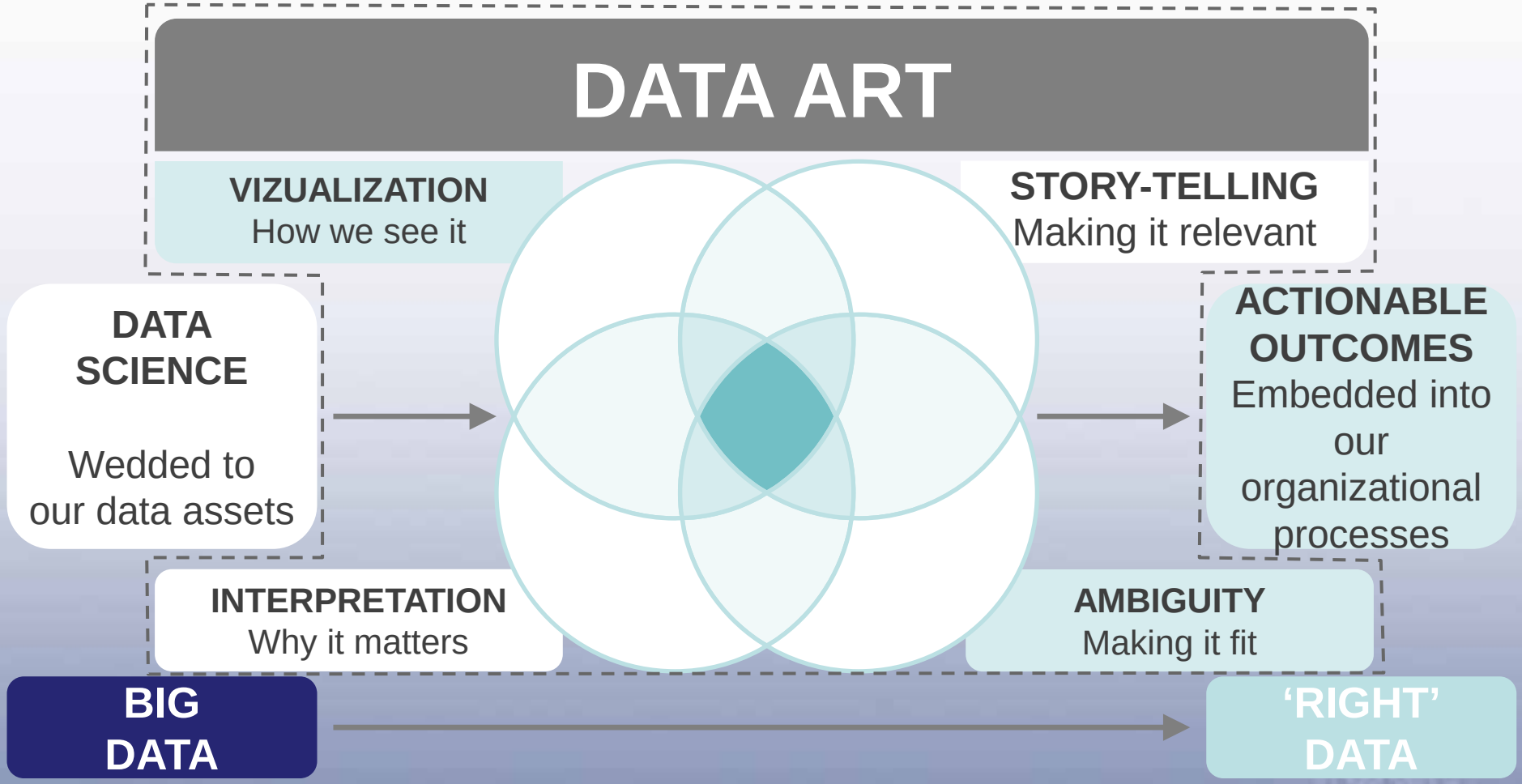
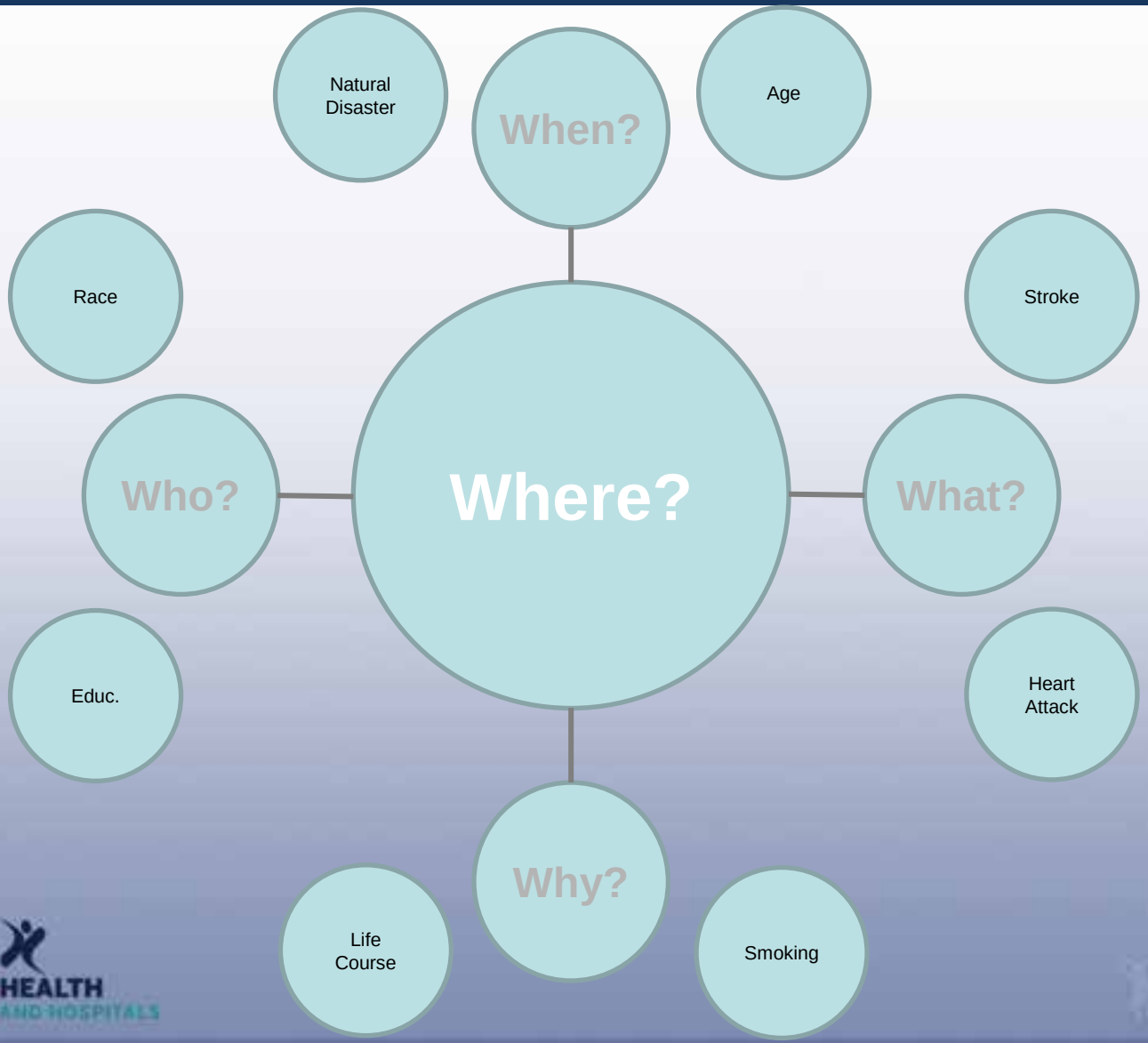
Executive Summary

- This effort utilizes departmental data on Licensed Adult ICU beds in Louisiana (1,294).
- Combining information about demand and delivery: population, morbidity, and road networks reveals spatial patterns of access.
- Neighborhood birth weight averages were calculated.
- Access can be measured in different ways though we should be focused on where there's agreement.
- Louisiana is not a "Certificate of Need" state but this application could make that a more quantifiable and transparent process.
- This process is generally applicable to all bed types, not just Adult ICU.

The Challenge: What to do with “Big Data”



Location and Revelation



E2SFCA: Luo, 2009

Step 1: The catchment of physician location j is defined as the area within 30-min driving zone (Lee, 1991). Within each catchment, compute three travel time zones with minute breaks of 0–10, 10–20 and 20–30 min (zones 1–3, respectively). Search all population locations (k) that are within a threshold travel time zone (D_r) from location j (this is catchment area j), and compute the weighted physician-to-population ratio, R_j, within the catchment area as follows:

$$R_j = \frac{S_j}{\sum_{k\in\{d_{kj}\in D_r\}} P_k W_r} = \frac{S_j}{\sum_{k\in\{d_{kj}\in D_1\}} P_k W_1 + \sum_{k\in\{d_{kj}\in D_2\}} P_k W_2 + \sum_{k\in\{d_{kj}\in D_3\}} P_k W_3} \quad (4)$$

where P_k is the population of grid cell k falling within the catchment j ($d_{kj}\in D_r$), S_j the number of physicians at location j, d_{kj} the travel time between k and j, and D_r the rth travel time zone ($r = 1$–3) within the catchment. W_r is the distance weight for the rth travel time zone calculated from the Gaussian function, capturing the distance decay of access to the physician j.

Step 2: For each population location i, search all physician locations (j) that are within the 30 min travel time zone from location i (that is, catchment area i), and sum up the physician-to-population ratios (calculated in step 1), R_j, at these locations as follows:

$$A_i^F = \sum_{j\in\{d_{ij}\in D_r\}} R_j W_r = \sum_{j\in\{d_{ij}\in D_1\}} R_j W_1 + \sum_{j\in\{d_{ij}\in D_2\}} R_j W_2 + \sum_{j\in\{d_{ij}\in D_3\}} R_j W_3 \quad (5)$$

where A_i^F represents the accessibility of population at location i to physicians, R_j the physician-to-population ratio at physician location j that falls within the catchment centered at population i (that is, $d_{kj}\in D_r$), and d_{ij} the travel time between i and j. The same distance weights derived from the Gaussian function used in step 1 are applied to different travel time zones to account for distance decay.

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E2SFCA: Luo, 2009

Stage 1: Score each Destination (Hospitals)

$$R_j = \frac{S_j}{\sum_{k \in \{d_{kj} \in D_r\}} P_k W_r}$$

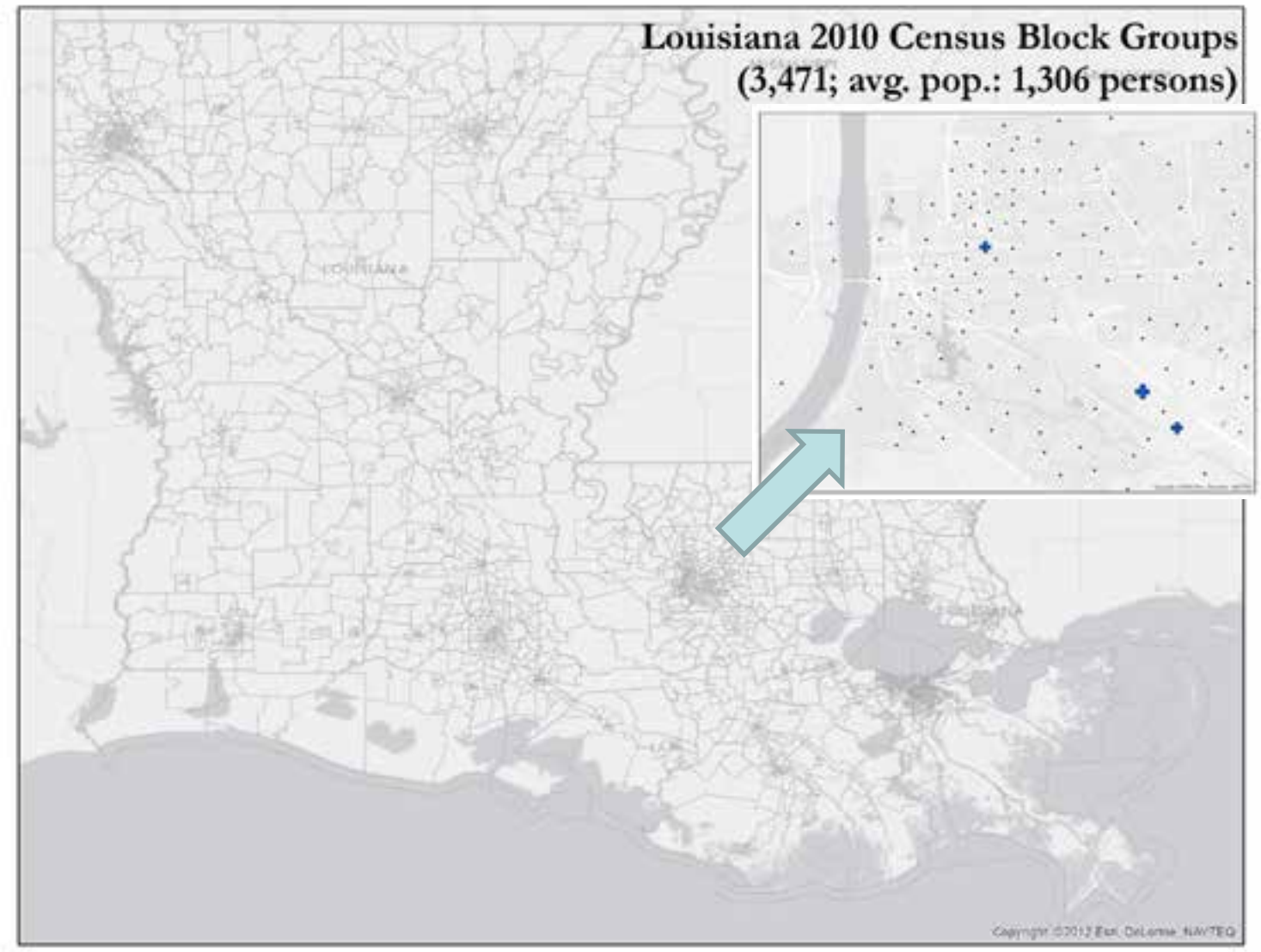
$$= \frac{S_j}{\sum_{k \in \{d_{kj} \in D_1\}} P_k W_1 + \sum_{k \in \{d_{kj} \in D_2\}} P_k W_2 + \sum_{k \in \{d_{kj} \in D_3\}} P_k W_3}$$

Stage 2: Score each Origin (Block Groups)

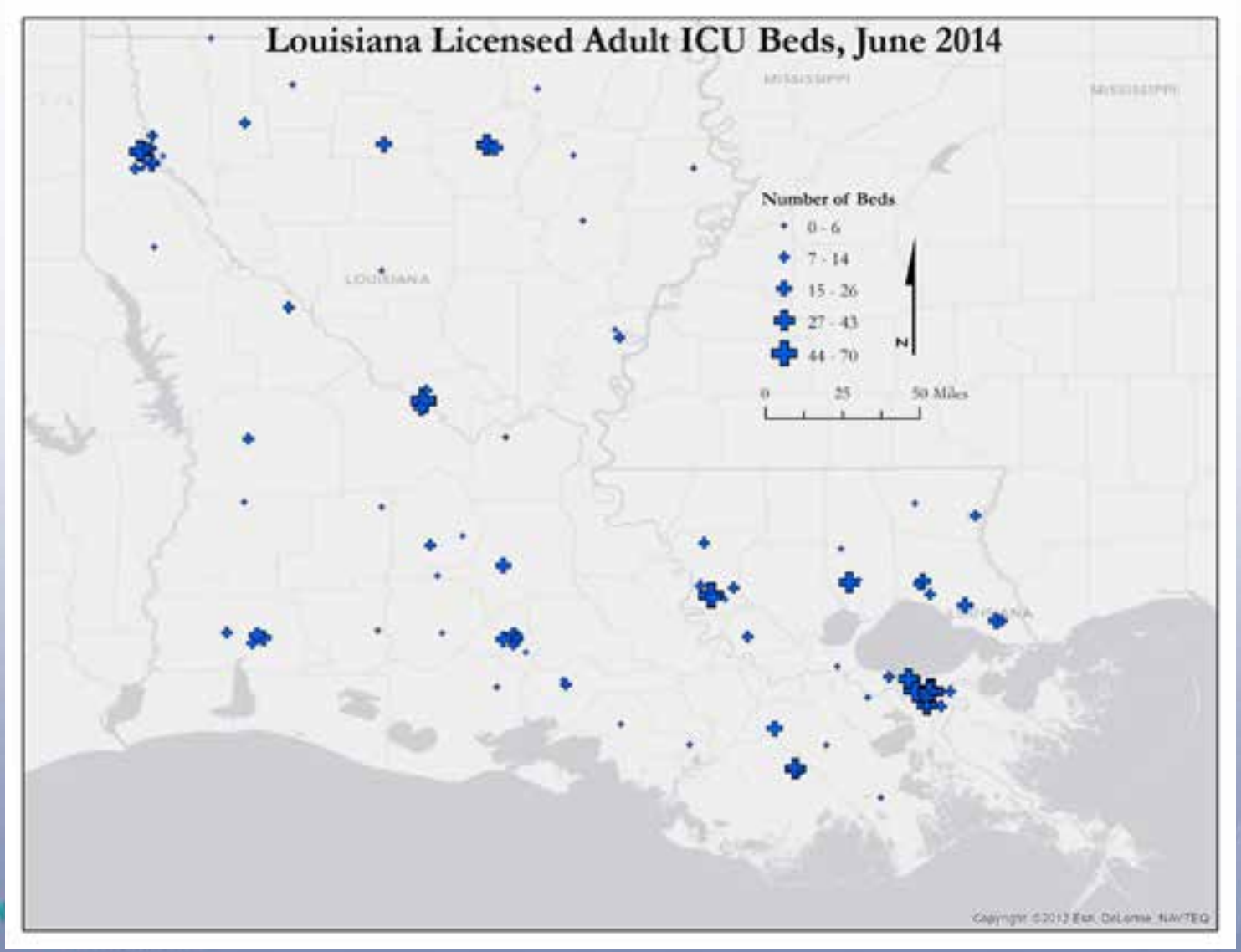
$$A_i^F = \sum_{j \in \{d_{ij} \in D_r\}} R_j W_r$$

$$= \sum_{j \in \{d_{ij} \in D_1\}} R_j W_1 + \sum_{j \in \{d_{ij} \in D_2\}} R_j W_2 + \sum_{j \in \{d_{ij} \in D_3\}} R_j W_3$$

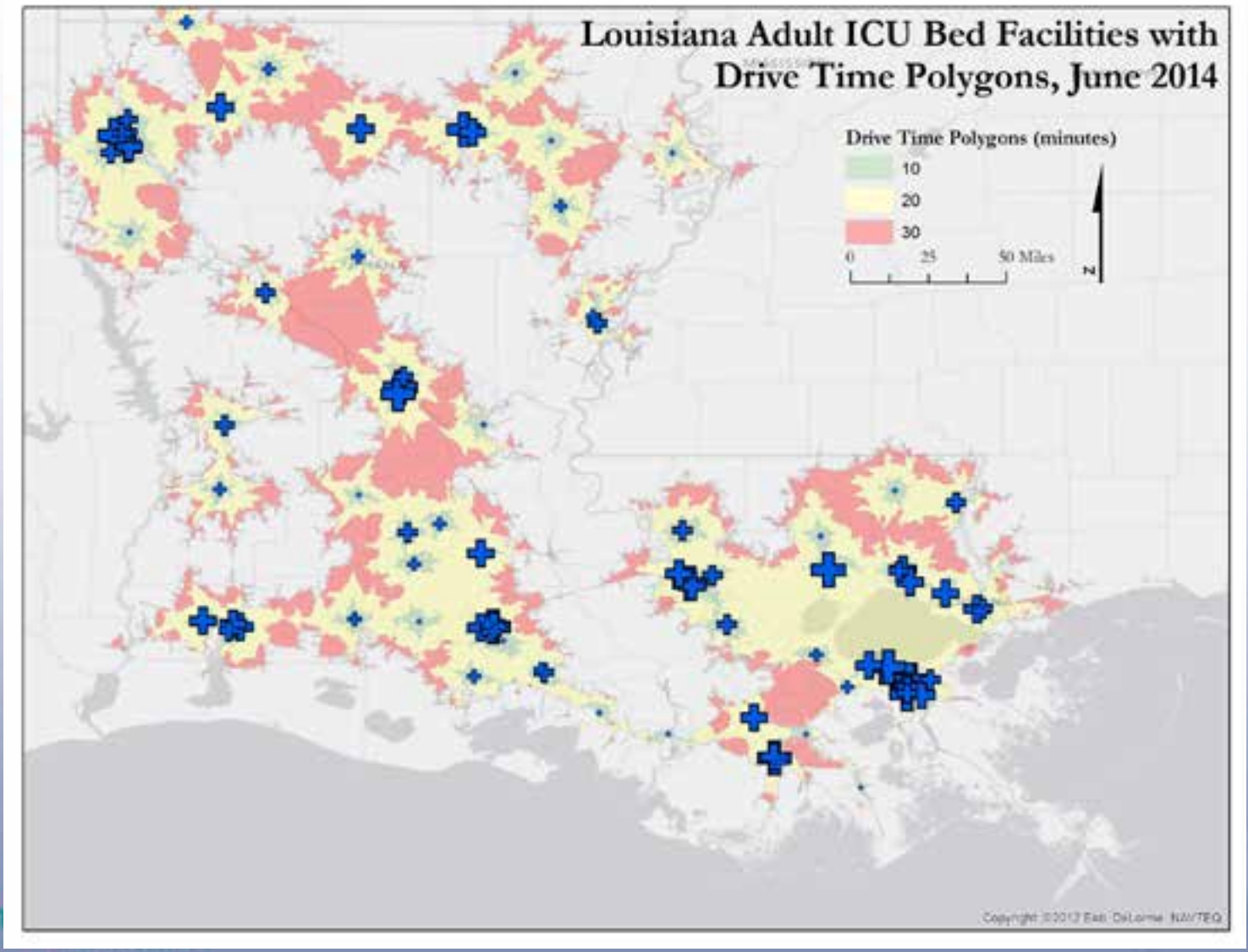
Census Block Groups (3,471)



Adult ICU Beds (96 Facilities)



Catchment Areas



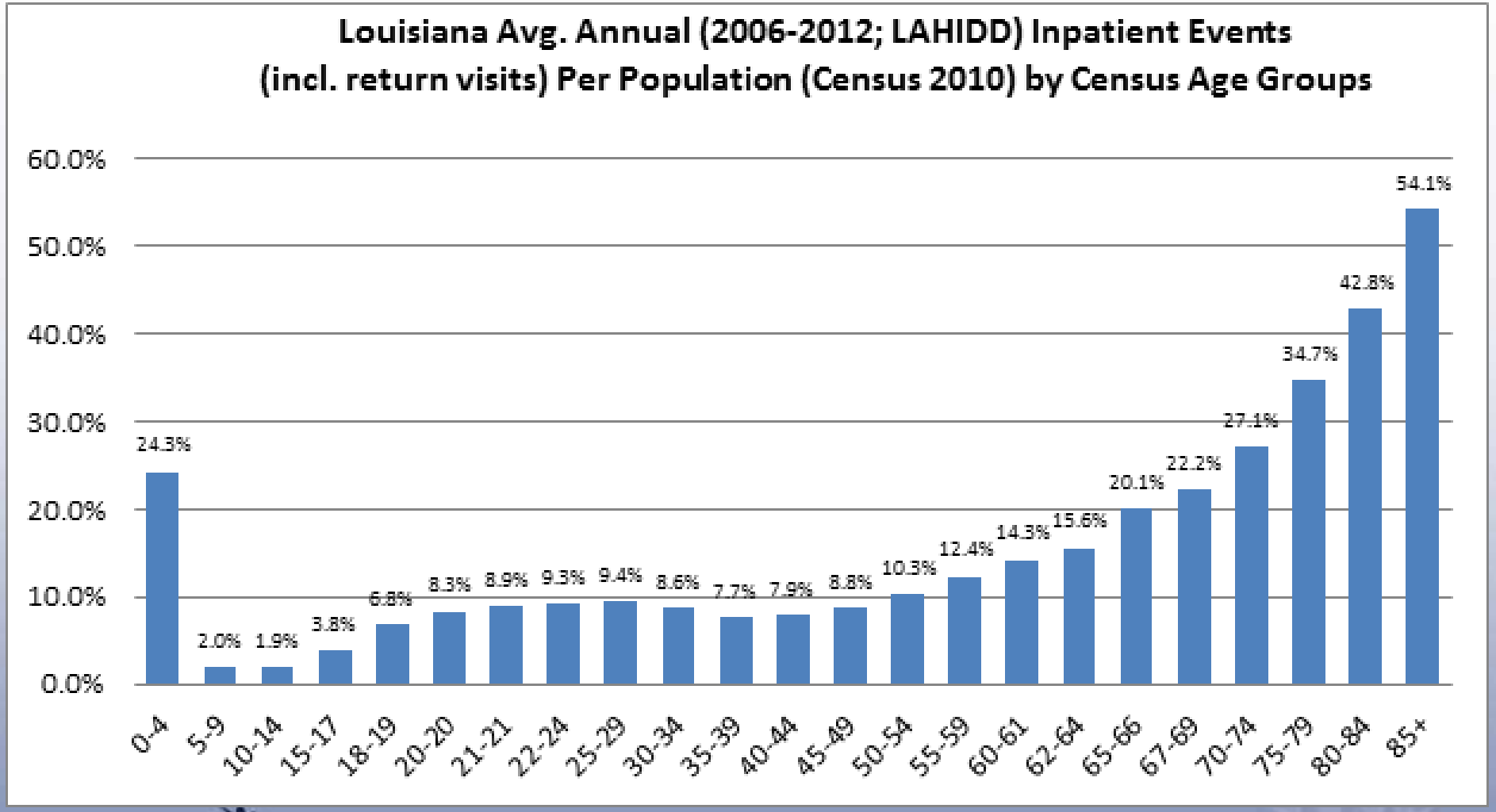
Major Improvements

- Created a continuous distance decay variable (1/t) for all block groups in lieu of catchment areas. *Replace W with 1/t!*

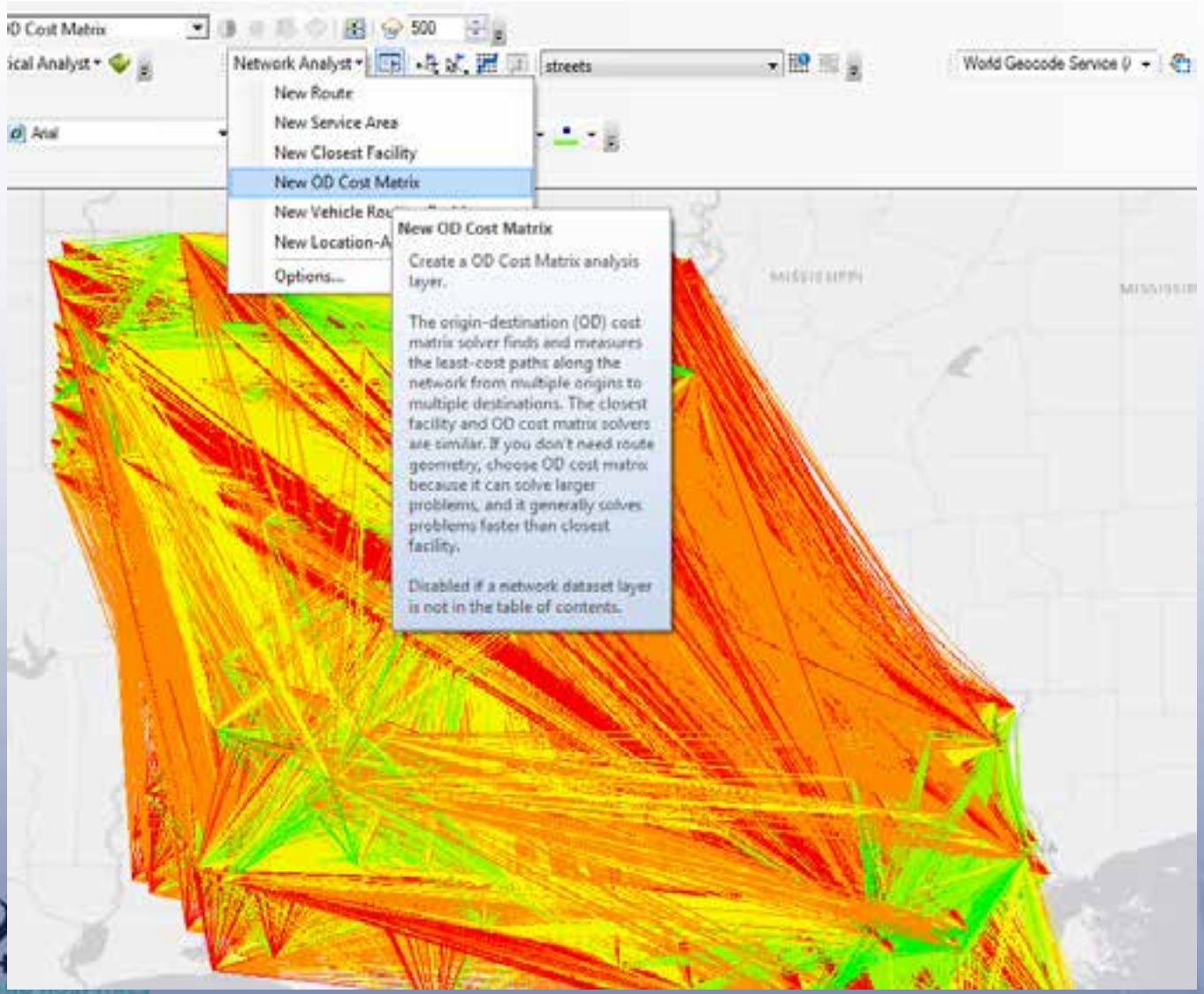
$$A_i^F = \sum_{j \in \{d_{ij} \in D_r\}} R_j W_r$$
$$= \sum_{j \in \{d_{ij} \in D_1\}} R_j W_1 + \sum_{j \in \{d_{ij} \in D_2\}} R_j W_2 + \sum_{j \in \{d_{ij} \in D_3\}} R_j W_3$$

- Included morbidity data for each Block Group

LAHIDD


Louisiana Avg. Annual (2006-2012; LAHIDD) Inpatient Events
(incl. return visits) Per Population (Census 2010) by Census Age Groups
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
24.3%
2.0%
1.9%
3.8%
6.8%
8.3%
8.9%
9.3%
9.4%
8.6%
7.7%
7.9%
8.8%
10.3%
12.4%
14.3%
15.6%
20.1%
22.2%
27.1%
34.7%
42.8%
54.1%
0-4
5-9
10-14
15-17
18-19
20-20
21-21
22-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-61
62-64
65-66
67-69
70-74
75-79
80-84
85+

3,471 Origins to 96 Destinations!?



Output

ObjectID	Shape	Name	OriginID	DestinationID	DestinationRank	Total_Time
963395	Polyline	Location 1 - Location 27	1	27	1	54.947253
963396	Polyline	Location 1 - Location 69	1	69	2	67.351047
963397	Polyline	Location 1 - Location 61	1	61	3	77.900389
963398	Polyline	Location 1 - Location 35	1	35	4	94.362089
963399	Polyline	Location 1 - Location 38	1	38	5	97.808191
963400	Polyline	Location 1 - Location 84	1	84	6	98.332365
963401	Polyline	Location 1 - Location 76	1	76	7	126.123347
963402	Polyline	Location 1 - Location 46	1	46	8	132.601387
963403	Polyline	Location 1 - Location 42	1	42	9	138.026219
963404	Polyline	Location 1 - Location 95	1	95	10	159.108571
963405	Polyline	Location 1 - Location 29	1	29	11	169.093493
963406	Polyline	Location 1 - Location 73	1	73	12	178.653985

Weighting Origins

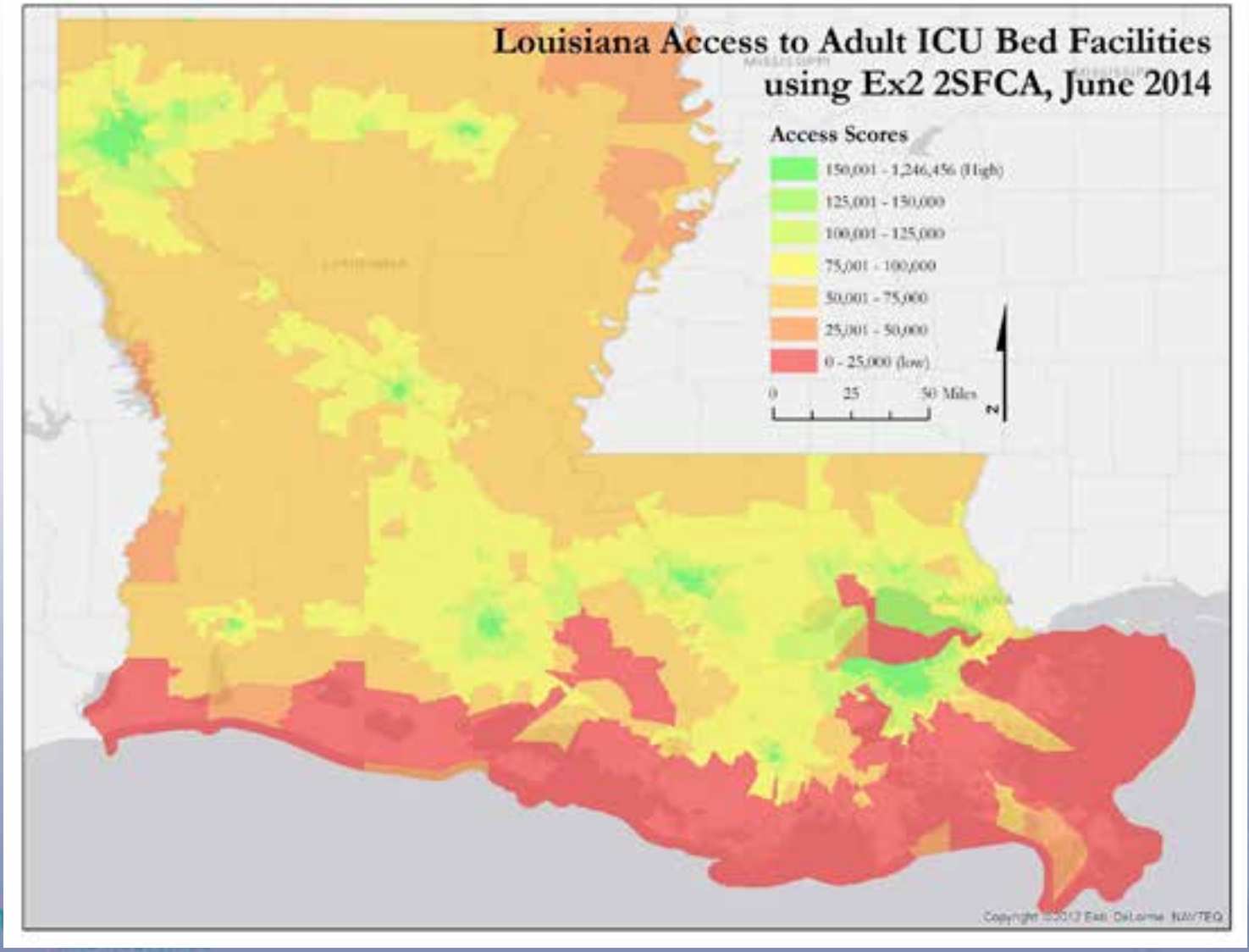
	areakey	p75	w75	pw75	ptot	pwtot
1.	220019601001	38	.2714734	10.31599	1269	158.1265
2.	220019601002	39	.2714734	10.58746	1266	153.0864
3.	220019601003	21	.2714734	5.700941	812	92.2829
4.	220019601004	62	.2714734	16.83135	1487	209.4903
5.	220019601005	46	.2714734	12.48778	1379	176.5574

What do we know now?

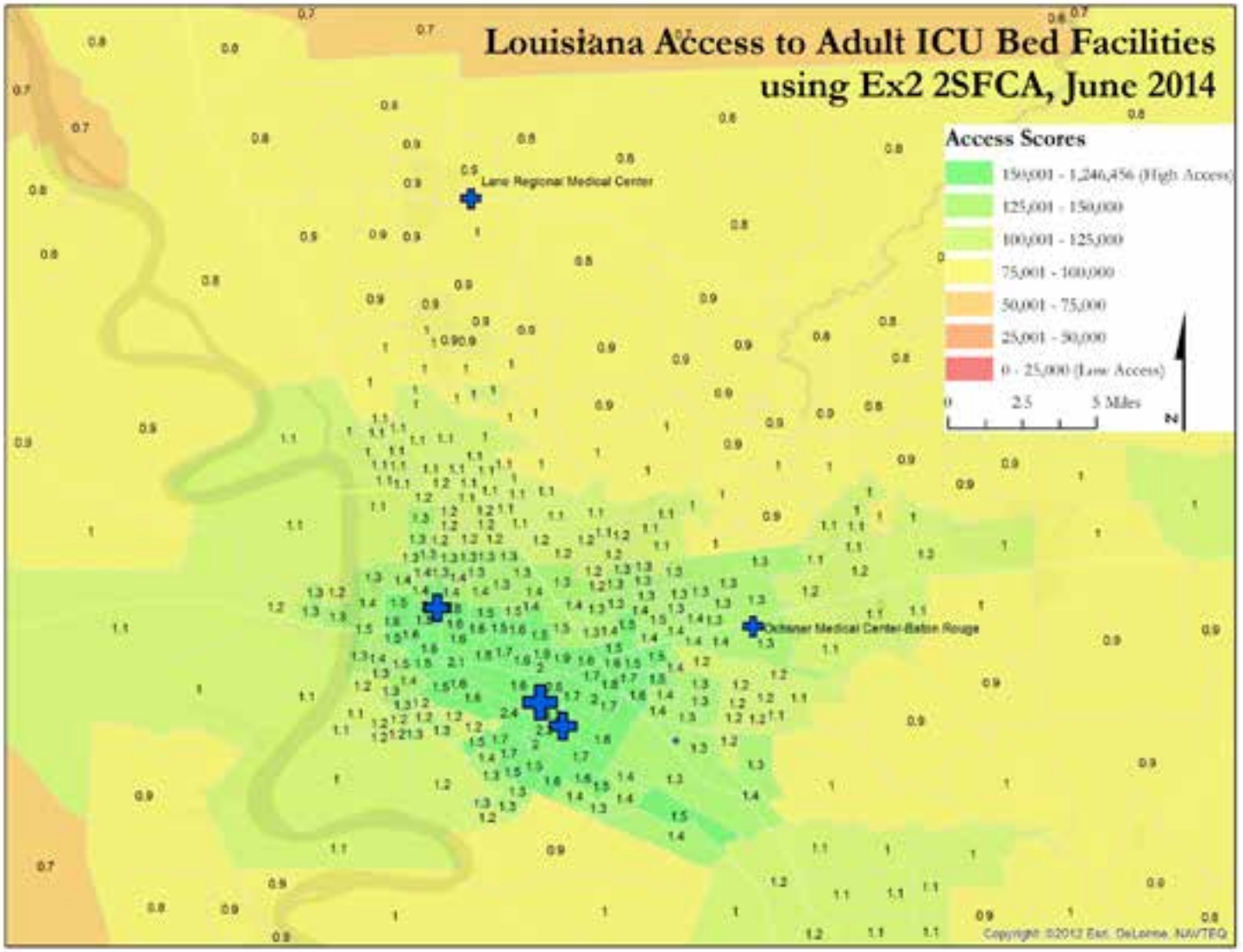
- Hospital Scores based on capacity and proximity AND morbidity -weighted demand

- Each Block Group's estimated demand and proximity to every hospital

Results


Louisiana Access to Adult ICU Bed Facilities
using Ex2 2SFCA, June 2014
Access Scores
150,001 - 1,246,456 (High)
125,001 - 150,000
100,001 - 125,000
75,001 - 100,000
50,001 - 75,000
25,001 - 50,000
0 - 25,000 (low)
0
25
50 Miles
N

Results


Louisiana Access to Adult ICU Bed Facilities
using Ex2 2SFCA, June 2014
Access Scores
150,001 - 1,246,456 (High Access)
125,001 - 150,000
100,001 - 125,000
75,001 - 100,000
50,001 - 75,000
25,001 - 50,000
0 - 25,000 (Low Access)
0
2.5
5 Miles
N
Lane Regional Medical Center
Ochsner Medical Center-Baton Rouge
Copyright ©2012 Esri, DeLorme, NAVTEQ

Distribution of Access Scores

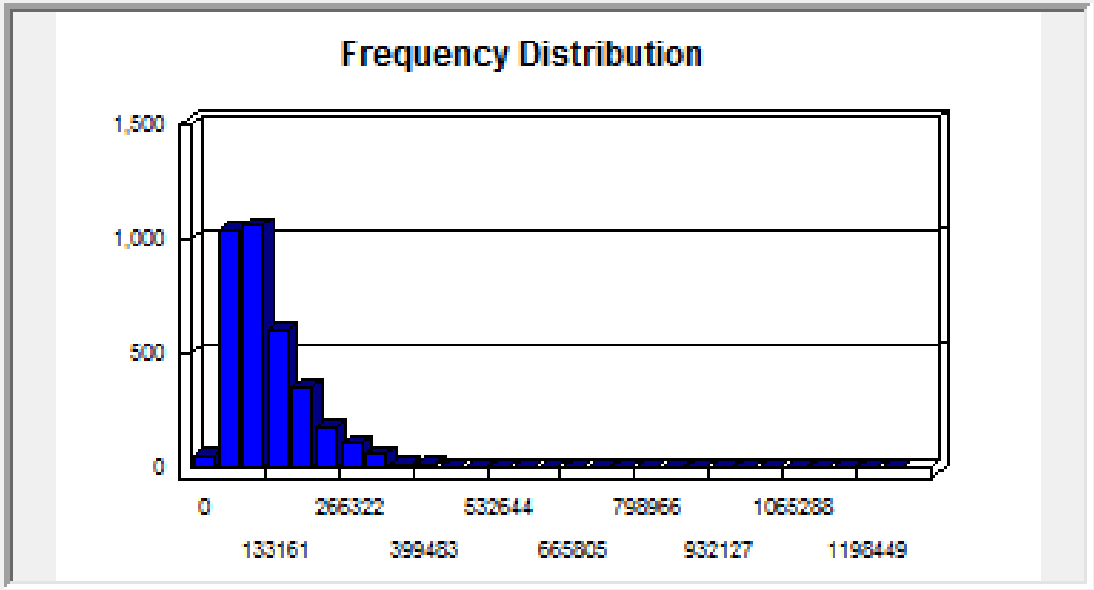
Statistics of tl_2010_22_bg10_BGAccess_txt

Field

a

Statistics:

Count: 3471
Minimum: 0
Maximum: 1246456
Sum: 460797991.990002
Mean: 132756.551999
Standard Deviation: 73512.401336
Nulls: 0



Future Work

- Share methodology/results with Partners
- Apply to other types of supply
- Refine population morbidity measures
- Predictive modeling

Thanks

Henry Yennie

Emergency Preparedness

Louisiana Department of Health and Hospitals

Cathy Brunson

Health Standards (Hospital Licensure)

Louisiana Department of Health and Hospitals

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Links

Papers on Floating Catchment Methods

http://illinoisruralhealthnet.org/geog/images/Using%20GIS%20Based%20Floating_2004.pdf

http://www.niu.edu/geog/images/Enhanced%20Twostep_2009.pdf

Esri Resources of Network Analyst

http://resources.arcgis.com/en/help/main/10.1/index.html#/What_is_the_ArcGIS_Network_Analyst_extension/004700000001000000/